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Application of Painless Dialysis in Blood Purification

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Abstract

Objective: In this study, dexmedetomidine was used in the process of dialysis to make patients fall asleep naturally, relieve pain, improve the quality of dialysis and improve the treatment outcomes.

Methods: The loading dose 1 ug/kg/h of dexmedetomidine was injected intravenously on the patient's body when the patient is treated. After adjusting the maintenance dose was 0.6~0.8 ug/kg/h, the dexmedetomidine was stopped 1.5 hours before the end of hemodialysis. The BIS value (bispectral index, reflecting the monitoring of anesthesia depth) was monitored in the whole process. The BIS value of the patients was less than 80 during hemodialysis. The BIS value and RASS score were recorded at 1 h, 2 h and the end of hemodialysis. After awakening, the patients' satisfaction was scored.

Results: All the patients entered into a state of natural sleep after using dexmedetomidine. The dialysis process was stable, and the patients were conscious after awakening. At the same time, most of the patients felt painless puncture, comfortable in body and mind, they all entered a deeper sleeping during dialysis.

Conclusion: The method is safe and effective, the effect is ideal and the patient's satisfaction is high. This method is used for patients who are sensitive to pain, have trouble sleeping, and are unable to tolerate dialysis.

Keywords: Hemodialysis; Dexmedetomidine; Bis (bispectral index); Painless; Sleep

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Introduction

Chronic renal failure refers to the irreversible and gradual decline of renal function, which eventually leads to a series of diseases and metabolic disorders, with uremia occurring at the end stage. It is reported that there are roughly more than 100 million patients with chronic kidney disease in China, including about 1 million with uremia, and the number of new cases is increasing by 10% each year. China is facing an increasingly aging population, and the number of cases of hypertension and diabetes also peak. It is estimated that the high-risk population may reach 15 million. At present, the main treatment methods for uremia are blood purification (hemodialysis and peritoneal dialysis) and kidney transplantation, which can prolong the patient's survival period and improve their quality of life, with the goal of correcting some of the patient's physiological indicators. As the dominant one, hemodialysis is a traumatic lifelong treatment. Vascular access is the "lifeline" for uremia patients on dialysis, and a good vascular access is the fundamental guarantee for the quality of dialysis. Autogenous arteriovenous fistula is the preferred choice of vascular access for maintenance hemodialysis. Patients on maintenance hemodialysis usually need to undergo dialysis 2-3 times a week, which means that they will be punctured six times with 16-18 gauge thick needles a week. The resulting pain often causes fear, anxiety, and depression, compromising the patient's compliance and quality of life. Long-term repeated puncture belongs to the category of chronic pain. The pain of internal fistula puncture is factor that affects the compliance of patients on maintenance hemodialysis. Some patients may delay or even give up treatment because of pain. Therefore, it is very important to carry out intervention research on the pain of internal fistula puncture for hemodialysis. Meanwhile, some patients may experience muscle spasms, bone pain caused by renal osteopathy, and ischemic neuropathy of internal arteriovenous fistula during dialysis, all of which can lead to severe discomfort and even failure to persist until the end of dialysis. In addition, physical discomfort caused by uremia, worries about illness, loss of work ability, and increased financial cost make uremia patients much more vulnerable to psychological problems than the normal population. In this regard, sedative and hypnotic drugs are often needed to help sleep, and the compromised quality of sleep all adversely affects the patients' normal work and life, seriously

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threatening their health. According to statistics, about 60%~80% of these patients have sleep disorders [1], which seriously threatens the health of patients. Therefore, it is necessary to develop a painless sleep hemodialysis technique that allows the patients to feel comfortable, calm, and pleased during four hours of hemodialysis. It will not only improve the patient's compliance, but also alleviate the anxiety, irritability, and other undesirable conditions. This will be conducive to improving the quality of dialysis and the prognosis of the patients. Therefore, in our hospital, painless sleep technique was used to put 10 patients in a physiological sleep state during hemodialysis. This not only reduced the pain caused by puncture and improved the compliance, but also improved the sleep quality, dialysis efficiency, and life quality of the patients, so as to promote the return of their social functions.

Patients and Methods

Patients

All cases were recruited from the Department of Blood Purification Center in the Xi'an People's Hospital/Xi'an No.4 Hospital. The primary disease for all patients was chronic glomerulonephritis, and the inclusion criteria were as follows: Stable blood pressure, absence of complicated infection and heart failure within the last 3 months, not pregnant or breast feeding, absence of severe cardiovascular and mental disorders. The patients were not taking any immunosuppressive agents. The patients had undergone regular hemodialysis treatment (4-hour treatment given 3 times a week) for more than 3 months using a dialysis solution (sugar-free, Ca^{2+} 1.5 mmol/L, K^+ 2.0 mmol/L). The dialysis membrane was polysulfone with an area of 1.4-1.8 m^2, and the blood flow was set to 220-250 mL/min, dialysate flow 500 mL/min. All of the patients had sleep disorder, anxiety, and normal ECG, normal chest X-ray and no contraindications to anesthesia.

This study was approved by the Ethics Committee in the Xi'an People's Hospital/Xi'an No.4 Hospital. Written informed consent was obtained from all patients in the study.

Specific procedures

Before hemodialysis, the arteriovenous fistula was prepared, oxygen inhalation was started, and the ECG, blood pressure, heart rate, respiration, and blood oxygen saturation were monitored. With the consent of the patient, painless physiological sleep hemodialysis was performed. During the operation, the depth of anesthesia was continuously monitored, the Bispectral Index (BIS) was recorded, and the patient was assessed with the Richmond Agitation-Sedation Scale (RASS). Through observing the sleep status of the patient, it is generally considered that a BIS value of 85~100 denotes the normal state, 65~85 the sedation state, and 40~65 the anesthesia state. The RASS is as follows:

The procedures of painless sleep hemodialysis were as follows: The patient was put in a supine position, and ECG monitoring and oxygen inhalation were performed routinely. The loading dose of dexmedetomidine was injected intravenously on the machine at 1 ug/kg/h for 30 minutes, and the dose was then adjusted to 0.6~0.8 ug/kg/h. Dexmedetomidine was discontinued 1.5 hours before the end of hemodialysis. If the heart rate was less than <50 beats/min during hemodialysis, 0.2 mg of atropine should be intravenously injected to keep the heart rate not less than 50 beats/min. During the hemodialysis, the patient's BIS <80 was maintained, and the BIS values and RASS ratings were recorded after hemodialysis for 1 h, for 2 h, and at the end of hemodialysis.

Outcome evaluation

The BIS values of some patients after hemodialysis for 1 h, for 2 h, and at the end of hemodialysis are shown in **Figure 1**. The BIS values of the 10 patients averaged 48.2 after hemodialysis for 1 h, 52.2 after 2 h, and 98 at the end of hemodialysis, as shown in **Table 1**. The RASS ratings average -1.5 after hemodialysis for 1 h, -1.1 after 2 h, and 0 at the end of hemodialysis, as shown in **Table 2**. In the satisfaction survey of patients after hemodialysis, 60% were "Very satisfied", 20% were "Mostly satisfied", and 20% were "Satisfied", as shown in **Table 3**.

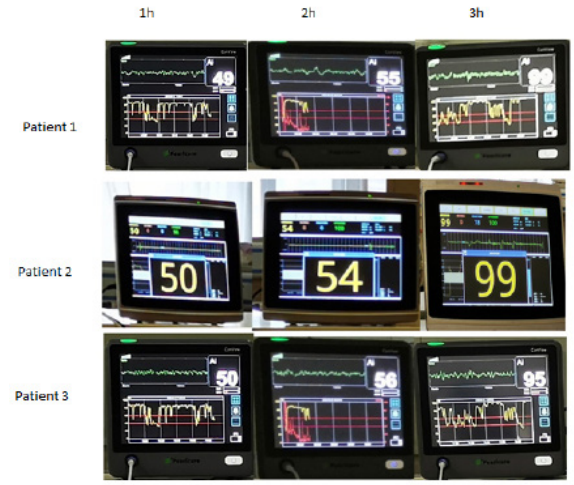

Figure 1: BIS of some patients after hemodialysis for 1 h, for 2 h, and at the end of hemodialysis.

Table 1: BIS of the 10 patients after hemodialysis for 1 h, for 2 h, and at the end of hemodialysis.

	Hemodialysis for 1 h	Hemodialysis for 2 h	Hemodialysis end
Patient 1	48	51	100
Patient 2	49	52	99
Patient 3	50	54	98
Patient 4	46	50	95
Patient 5	48	53	98
Patient 6	47	52	100
Patient 7	50	54	96
Patient 8	48	52	97
Patient 9	51	55	100
Patient 10	45	49	97

Table 2: RASS rating of the 10 after hemodialysis for 1 h, for 2 h, and at the end of hemodialysis.

	Hemodialysis for 1 h	Hemodialysis for 2 h	Hemodialysis end
Patient 1	-2	-2	0
Patient 2	-2	-1	0
Patient 3	-1	-1	0
Patient 4	-1	-1	0
Patient 5	-2	-1	0
Patient 6	-1	-1	0
Patient 7	-2	-1	0
Patient 8	-2	-1	0
Patient 9	-1	-1	0
Patient 10	-1	-1	0

Table 3: Satisfaction of the 10 patients.

	Satisfaction
Patient 1	Very satisfied
Patient 2	Mostly satisfied
Patient 3	Mostly satisfied
Patient 4	Very satisfied
Patient 5	Mostly satisfied
Patient 6	Very satisfied
Patient 7	Very satisfied
Patient 8	Very satisfied
Patient 9	Very satisfied
Patient 10	Mostly satisfied

Results and Discussion

Dexmedetomidine hydrochloride is a dextrorotatory isomer of medetomidine, the α2-adrenergic receptor agonist. Compared with medetomidine, this product is more selective for central α2-adrenergic receptor activation, with a half-life of about 2 hours. With a small dosage required, it has obvious sedative, analgesic, and anti-anxiety effects. It is clinically suitable for sedation of patients who undergo intubation and use ventilator during intensive care treatment [2]. The sedative effect of dexmedetomidine works like natural sleep, which is a kind of "sedation that can be awakened anytime", without obvious inhibitory effect on respiratory functions [3-6]. Therefore, it is considered that dexmedetomidine has a "good and safe sedative effect". Physical discomfort caused by uremia, worries about illness, loss of work ability, and increased financial cost make uremia patients much more vulnerable to sleep disorders than the normal population. For this reason, we believe that the use of dexmedetomidine may help restore the biological rhythms of uremia patients with sleep disorders and sleep inversions. Dexmedetomidine produces anti-sympathetic effects by activating brainstem locus coeruleus neuron α2A receptors, and prevents sympathetic nerve excitement induced by controlled blood pressure reduction, thereby facilitating the process of controlled blood pressure reduction. Studies have shown that it has achieved good results when used as an auxiliary for controlled blood pressure reduction in ENT, orthopedic, and other operations [7-9]. Hypertension has a high incidence among hemodialysis patients [10]. Factors such as increased extracellular fluid volume, increased activity of the RAS system, excessive excitement of the sympathetic nervous system, and excessive secretion of vasoactive substances lead to increased blood pressure. Dexmedetomidine has an anti-sympathetic effect, making blood pressure easy to control. Therefore, the use of dexmedetomidine in dormant dialysis for patients with recurrent hypertension that is difficult to control may help control the increased blood pressure in dialysis.

A large number of studies have confirmed that 50%-80% of dialysis patients suffer from pain caused by long-term repeated puncture. Some patients may experience muscle cramps, bone pain caused by renal osteopathy, and arteriovenous fistula ischemic neuropathy during the dialysis process, all of which can lead to severe discomfort and even failure to persist until the end of dialysis. Moreover, maintaining a fixed posture during dialysis for up to 4 hours often causes discomfort in the lower back, legs, neck, and shoulders of the patients. Dexmedetomidine has significant analgesic and sedative effects and can significantly relieve the interruption of dialysis caused by pain and discomfort induced by various reasons. Blood purification is one of the effective methods for the treatment of acute and chronic renal failure, including hemodialysis, hemoperfusion, continuous renal replacement therapy, and peritoneal dialysis. While removing the metabolic and toxic products in the patient, it can also remove some drugs, so it is mainly used to remove small molecular weight and non-fat-soluble toxicants from the blood. Dexmedetomidine is a low-molecular-weight drug that can be eliminated by blood purification. Continuous administration two hours before dialysis allows patients to enter natural sleep, and the drug is stopped two hours later. The residual drugs can be removed by blood purification. Meanwhile, dexmedetomidine is metabolized by the liver to produce inactive metabolites, which are excreted through the kidneys and feces. Because its metabolites are inactive, renal dysfunction does not affect its pharmacokinetics, and impaired liver function will affect its clearance rate. Therefore, there is no obvious contraindication to the use for patients with renal failure [11-15].

Conclusion

At present, the related reports of painless dialysis mainly focus on the aspect of "painless puncture", which is achieved mainly through local anesthesia of the skin surface, such as subcutaneous injection of lidocaine injection, or skin surface application of lidocaine cream and tetracaine cream [11-15]. However, the reactive pain threshold varies greatly between individuals. Some patients still have not achieved the desired results, and maintaining a fixed posture during dialysis for up to 4 hours often brings obvious discomfort to the patients. The results of this treatment showed that 10 patients received a 30-minute loading dose upon the start of hemodialysis and were in sleep state after 1 h and 2 h. The BIS value was lower than 80, and the sedation rating was also 0~-2. Most patients had high satisfaction after

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hemodialysis. During painless sleep hemodialysis, the patients were in a calm and natural sleep state during 4 h of hemodialysis, with stable vital signs, improved comfort, and reduced negative emotions, which help improve the overall quality of dialysis.

In summary, the use of dexmedetomidine during hemodialysis can deliver analgesic, sedative, and anti-anxiety effects, as a safe, effective, and feasible solution. Not only can it improve the tolerance to dialysis and improve the quality of dialysis while eliminating toxins and maintaining life, but also improve patients' various mental and psychological disorders, offering painless dialysis, sleep dialysis, and “happy dialysis”.

The method is safe and effective, the effect is ideal and the patient’s satisfaction is high. This method is used for patients who are sensitive to pain, have trouble sleeping, and are unable to tolerate dialysis.

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